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PAPER: "AECL'S PARTICIPATION IN THE COMMISSIONING OF
POINT LEPRFAU GENERATING STATION UNIT 1"

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1.0 INTRODUCTION

A major milestone in the history of CANDU nuclear reactors was reached on 1983 January 31 when New Brunswick Electric Power Commission (NBEPCC) declared the Point Lepreau Generating Station, Unit 1 to be "in service". Electricity was generated at the full rated output on 1983 March 27.

The unit's progress from criticality to full electrical output is depicted in Figure 1.

This paper focusses on only one aspect of the project - that of the Atomic Energy of Canada Limited's participation during the commissioning stage.

Responsibility for the design, supply, construction, testing, commissioning, and initial power operation was split between NBEPCC, AECL, and Canatom as shown in the organizational chart for the Point Lepreau Project (Figure 2).

AECL acted in the role of engineer, designer, and supplier responsible to NBEPCC and provided:

The engineering services for the design of nuclear steam supply systems (NSSS);

procurement services for nuclear class process systems and associated instrumentation;

training of a number of NBEPCC engineers and scientists, commissioning, and operating personnel;

engineering liaison during construction and commissioning to resolve problems related to AECL designs; and

staff to assist in resident engineering and commissioning services.

Engineering liaison, resident engineering, and commissioning services were the major areas in which AECL participated during the various phases of commissioning through to full power.

2.0 COMMISSIONING OVERVIEW

Generally speaking, the various stages of any commissioning program can be categorized as a review of requirements, preparation of test objectives, preparation of detailed procedures to accomplish these test objectives, review of test procedures by all parties involved in a test, scheduling of a test by the planning group, execution by the operating shifts to procedures prepared and assisted by the Commissioning team, and eventually the preparation of the commissioning reports.

For planning purposes, commissioning a CANDU station is normally divided into three phases:

Phase A commissioning involves completion of all work in preparation for fuel loading and reactor criticality.

Phase B commissioning includes manual fuel loading through to criticality, and ends with performance tests for the reactor regulating and protective systems at low powers (less than 0.1% full power). The physics performance of the reactor is confirmed at this stage.

Phase C commissioning is the power run-up phase during which commissioning tests are carried out at increasing powers until full power operation is achieved.

Figure 3 depicts the overall site program from the start of construction through to full power.

3.0 AECL PARTICIPATION IN THE COMMISSIONING PROGRAM

AECL involvement in the commissioning program can be categorized as follows:

3.1 Engineering and Technical Assistance

Engineering and technical service and assistance was provided on an "on call" basis in the areas of NSSS, process and safety systems, and related electrical instrumentation and control systems, together with licensing assistance and inspection services. The assistance provided included

problem solving,
review of equipment performance,
procurement of hardware,
supporting analytical work,
preparation and review of procedures,
review and analysis of test data,
the tuning of the design and analytical codes to the station's
"as commissioned" conditions.

Assistance was also provided in the areas of start-up support and in the operation of the special physics test instruction, data collection and analysis.

AECL designers at Sheridan Park and Montreal offices were actively involved in the commissioning program and worked in close association with the Nuclear Operations Group. The policy of involving AECL designers and analysts in the commissioning program was consistently followed by NBEPC management. This involvement provided additional assurance that the commissioning would be carried out in a manner commensurate with design intent, and provided a feedback of commissioning information to the design engineers.

Commissioning procedures were prepared by NBEPC to meet the design requirements for the verification of process design and safety analysis as outlined in the various design documents (i.e. design manuals, safety design matrices, safety reports, etc.). AECL designers provided a review of several Level 2 and Level 3 procedures for systems for which AECL had the design and supply responsibility, for example reactor physics and heat transport system specialists reviewed the commissioning test procedures for physics and reactor control and major commissioning tests such as heat transport stability, "crash cooldown" and thermosyphoning.

Designers were frequently consulted on various aspects of other significant commissioning tests. Some of the commissioning data, particularly in the area of reactor physics and thermo-hydraulics, was also analyzed by AECL.

Any changes to the basic design intent of the process systems resulting from the commissioning process were reviewed by the designers and formally accepted before they were incorporated at the station.

This service and assistance was made possible in three ways:

1. Sending design and other technical personnel as required by NBEPC, for short terms (one day to two weeks) to Point Lepreau site to resolve problems and recommend appropriate modifications, without jeopardizing the design intent.
2. Arranging to carry out engineering modifications initiated either by NBEPC or AECL as a result of commissioning tests, but only after the impact of such changes on the safety design of the systems had been properly assessed.
3. Feedback of system and equipment modifications made or problems encountered on other CANDU stations.

3.1.1 Site Change Approvals

As a part of the engineering assistance program, AECL design staff participated in the reviews and approval mechanism set for changes initiated by NBEPC during the commissioning phase on systems designed by AECL.

It was necessary as a part of the commissioning assurances to be provided to the AECB by the utility, that changes made at site to safety and safety related systems be reviewed and approved by AECL as the design authority.

3.1.2 Commissioning Liaison

Very close liaison with the Nuclear Operations Group site staff was necessary during the commissioning period as short turn-round time was crucial for problem solving.

This requirement was effectively met by setting up a team dedicated to providing commissioning liaison and assistance to the Nuclear Operations Group separate from the Project Engineering Manager as noted in Figure 4.

3.2 Secondment Support

Technical personnel were seconded by AECL to NBEPC to work at site during the pre-commissioning and commissioning phases. Seconded technical staff were located full time at the plant site working under Nuclear Operations Group supervision on various NSSS and balance of plant systems commissioning and on the overall program co-ordination and program management.

These specialists had design background for the various process systems. They were able to propose tests to demonstrate system strengths and bring out any weaknesses for correction. Their participation is described below:

3.2.1 Direct Commissioning Work

Out of a total of approximately 200 systems, AECL seconded staff participated directly in the pre-commissioning and commissioning activities of approximately 85. The major systems commissioned with secondment support are listed in Figure 5.

The activities associated with pre-commissioning and commissioning start with acceptance of turnover packages from construction, and finished with the turnover of systems to the Commissioning team.

3.2.2 Technical Co-ordination of Commissioning Program

Quite early in the program, technical co-ordinators were appointed to spearhead the advance planning for Phase B and Phase C commissioning. These co-ordinators were responsible for the definition of the basic requirements of the commissioning program as outlined in the various design documents (such as design manuals, safety design matrices, safety reports, etc.) and based on the commissioning programs of previous CANDU stations.

AECL seconded staff were involved with the strategic planning and test co-ordination for the Phase B and Phase C commissioning program. Technical objectives for the various commissioning tests were outlined taking into account any known or anticipated licensing requirements. Appropriate input and review by all commissioning groups formed an essential part of this iterative process. Level 2 commissioning co-ordination procedures were the outcome of this process. These procedures, after review by the licensing authority, became the "reference" plans for Phases B and C.

Technical co-ordinators were also involved in reviewing the detailed commissioning procedures to ensure compliance with test objectives, and in identifying commissioning documentation requirements and co-ordinating submission of commissioning reports to the AECB. Test co-ordinators (different from technical co-ordinators) were responsible for co-ordination of technical problems on a day to day basis.

3.2.3 Commissioning Program Management

Commissioning program management was given the task of defining achievement targets, establishing work priorities, allocating resources, monitoring progress and ensuring that road blocks to progress were removed. It was the responsibility of the program management group to modify the commissioning program on a daily basis to accommodate changing circumstances. AECL seconded staff also participated in the management of the commissioning program on a daily basis.

3.3 Other Services

3.3.1 D₂O Upgrader

AECL carried out computer simulation studies to provide a guide to the system's capabilities so that the operators could easily determine the rates of feed to use at the various feed points for given top and bottom concentrations for the upgrader packed columns.

3.3.2 Initial Fuel Loading

The initial fuel loading was completed in less than nine days in two twelve-hour shifts. A forty member crew was involved in the fuel loading including twelve technicians from AECL Sheridan Park Engineering Laboratory.

3.3.3 Physics Support (Commissioning and Analysis)

As noted earlier, AECL's services were made available to NBEPCC throughout Phase B commissioning to contribute towards reactor criticality and subsequent reactor control and physics tests. The reactor physics specialists worked on shift with NBEPCC commissioning team. This team was responsible for supporting the operating shift during startup and operation of the special physics test instrumentation and data collection. AECL also carried out detailed data analysis and simulation studies of physics data gathered during Phase B and Phase C physics tests. In addition, one physicist from AECL was attached full time to the commissioning group to participate in planning as well as the actual execution of the tests and preparation of commissioning reports.

4.0 TOTAL EFFORT

AECL's staff seconded to site worked a total of 63 manyears, which amounts to approximately 28% of NBEPCC's Nuclear Operations Group's technical effort in the same period. This figure does not include management, administrative, maintenance, and field operations activities necessary in the total commissioning effort. The total commissioning support in terms of man-years worked both by staff at AECL offices and by the seconded staff is given in Figure 6.

Figure 7 lists the number of AECL staff seconded to Point Lepreau site since 1978. Secondment periods ranged from a few days to over three years.

5.0 SUMMARY

In summary, AECL's support to Point Lepreau during the commissioning program has been in the form of:

Seconded staff for commissioning program management, preparation of commissioning procedures, and hands-on commissioning of several systems.

Analysis of test results.

Engineering service for problem solving and modifications.

Design engineering for changes and additions.

Procurement of urgently needed parts and materials.

Technological advice.

Review of operational limits.

Interpretation of design manuals and assistance with and preparation of submissions to regulatory authorities.

Development of equipment and procedures for inspection and repairs.

The above, together with AECL's experience in the commissioning of other 600 MWe stations, Douglas Point, and Ontario Hydro stations, provides AECL with a wide range of expertise for providing Operating Station Support Services for CANDU stations.

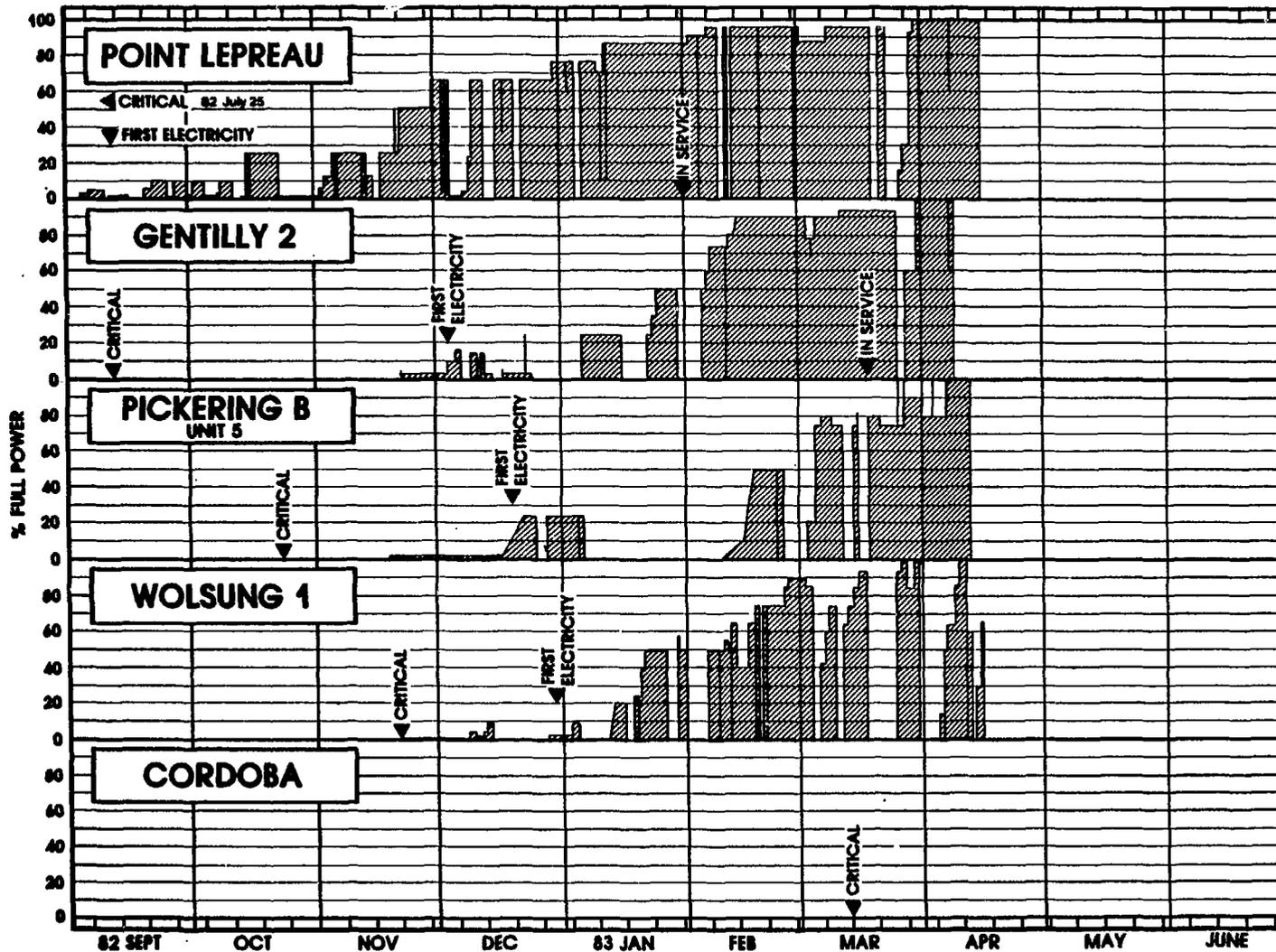


FIGURE 1 CANDU STATION PERFORMANCE

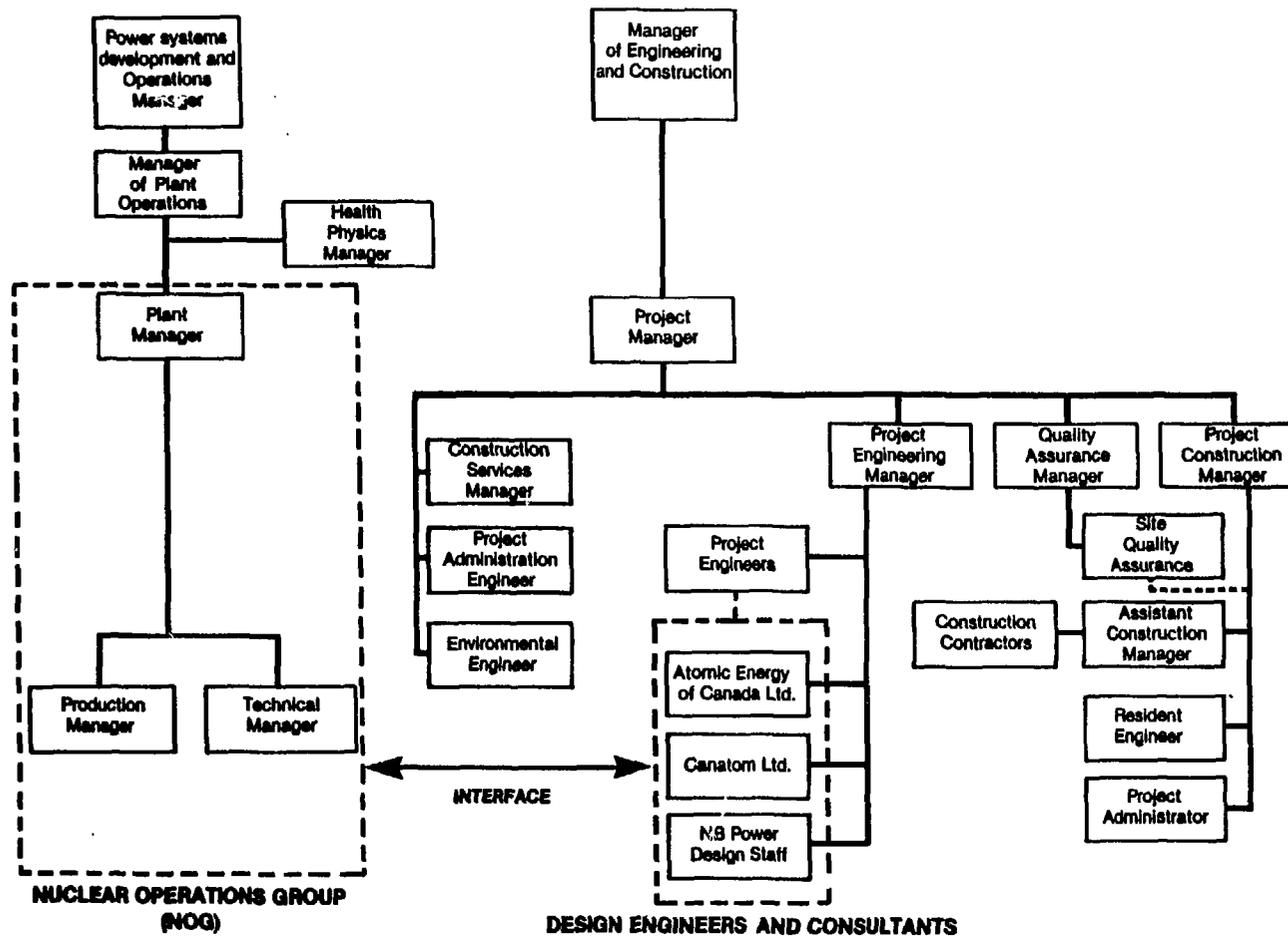


FIGURE 2 ORGANIZATIONAL CHART FOR POINT LEPREAU PROJECT

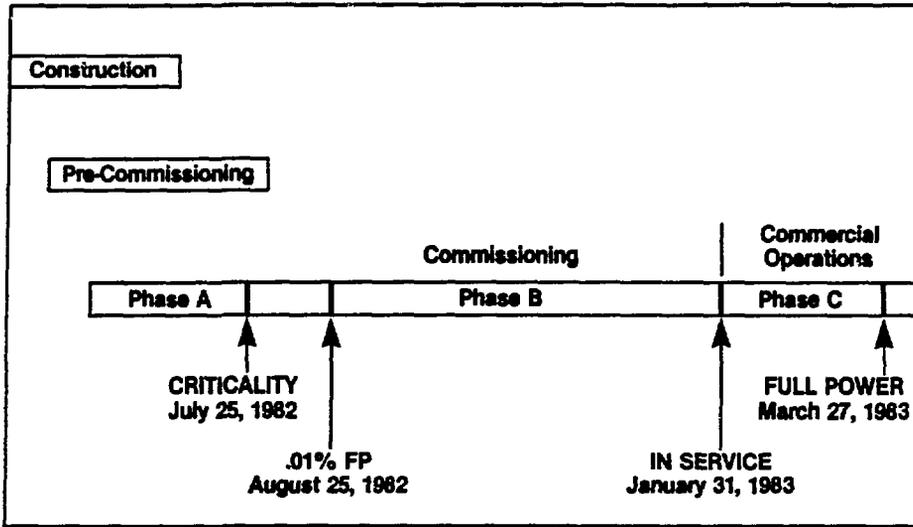


FIGURE 3 UNIT 1 OVERALL SITE PROGRAM

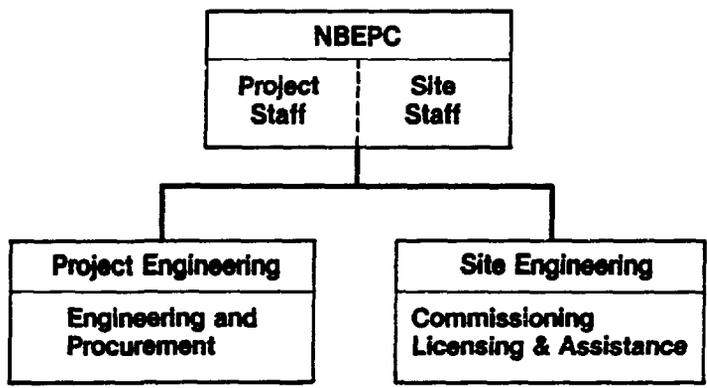


FIGURE 4 ORGANIZATION

- **Primary Heat Transport System and Auxiliaries**
- **Fuel Handling**
- **Heavy Water Management**
- **Boiler Level and Pressure Control**
- **Heating, Ventilation and Air Conditioning**
- **Balance of Plant (Feedwater and Condensate Systems)**
- **Process Control for Various Systems**
- **Emergency Core Cooling**
- **Emergency Power Supply**
- **Liquid Zone Control**
- **D₂O Upgrader**
- **Electrical Power System**

FIGURE 5 MAJOR SYSTEMS COMMISSIONED WITH AECL ASSISTANCE AT SITE

Effort at AECL offices 57 manyears	Effort at site 63 manyears
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FIGURE 6 AECL COMMISSIONING SUPPORT (TECHNICAL)

1978	_____	3
1979	_____	10
1980	_____	27
1981	_____	46
1982	_____	29
1983	_____	13

FIGURE 7 NUMBER OF AECL STAFF SECONDED TO NBEP